REMARKS

Reconsideration and allowance of the subject application are respectfully requested. Claims 2-5, 7-13, 15, and 17-20 are now pending. In this Reply, Applicant has cancelled claims 1, 6, 14, and 16 without prejudice or disclaimer, has added new claims 17-20, has amended claims 2, 4, 5, 7, 9, 10, 12, 13, and 15, and has amended the specification in a manner discussed below.

Objection to the Drawings

As set forth on page 2 of the Office Action, the Examiner objects to the drawings as allegedly failing to show every feature of the claimed invention. At least for the following reasons, Applicant respectfully requests that the Examiner reconsider and withdraw the drawing objections.

Regarding the phrase "the image plane," Applicant directs the Examiner's attention to Fig. 1, which clearly illustrates element 7, which is a CCD array. Since an image is formed on the CCD array 7, Fig. 1 illustrates the location of an image plane. (See original specification, p. 5, lines 14-18). Regarding the phrase "the image axis," initially, Applicant notes that this phrase has been removed from the claims. In any event, Applicant respectfully submits that an image axis is clearly illustrated in Fig. 1. Regarding the phrase "the CCD array," Applicant again directs the Examiner's attention to element 7 in Fig. 1.

Regarding the element "the first cylindrical lens," Applicant directs the Examiner's attention to element 4 of Fig. 1.

Regarding the phrase "the second image axis," this phrase has been removed from the claims. Regarding the phrases "the second plurality of light transmitting and light blocking regions," "the second image plane," and "the second cylindrical lens," Applicant

has submitted a new figure, Fig. 3, with a Drawing Correction Authorization Request filed concurrently herewith to illustrate these claim elements.

Fig. 3 does not constitute new matter. Instead, Fig. 3 is merely an isometric view, which incorporates a number of elements arranged with respect to each other in a manner clearly evident from the original text and Figs. 1 and 2. The light source 13 positioned behind a barrier screen 2 is clearly described at p. 6, lines 31-32 of the original disclosure, and is also illustrated in the sectional view of Fig. 1. The positioning of patterns 20 and 21 is described at original p. 6, line 33 – p. 7, line 2. More specifically, these patterns are described as typically being separated by a considerable gap, with one pattern on the left hand side of the barrier screen and the other on the right hand side, as now illustrated in Fig. 3. The lenticular screen 1 is positioned in front of the barrier screen 2, as shown in the sectional view of Fig. 1 and described for example at original specification, p. 5, lines 2-3. In Fig. 1, the lenticular screen is shown to have a series of convergent elements, one of which is numbered element 4. See also p. 5, lines 9-11. In Fig. 3, two such elements are shown as elements 25 and 26, consistent with the original description and illustration of the disclosed embodiment. For clarity, lens 6 of original Fig. 1 and a counterpart for the second arrangement on the left hand side of the lenticular screen 1 are shown cut away for ease of illustration of apertures 22, 23, which are also shown in Fig. 2. The isometric view of Fig. 3 illustrates vertical motion 24 and horizontal motion 12 of the lenticular screen 1 relative to the barrier screen 2, as clearly described in the original specification, for example at p. 7, lines 9-30. Thus, the text as originally filed disclosed the arrangement as now illustrated in new Fig. 3, particularly in light of known arrangements on which the present invention improves. For sake of clarity and ease of description, minor amendments have

been made to the specification to include reference numerals for elements illustrated in Fig. 3, which are described in the original specification. Accordingly, these amendments to the specification likewise do not raise the issue of new matter.

In view of the above remarks and new Fig. 3, Applicant respectfully requests reconsideration and withdrawal of the objections to the drawings.

Rejection Under 35 U.S.C. § 112, First Paragraph

Claims 1-13 and 14-16 stand rejected under 35 U.S.C. § 112, first paragraph, as allegedly containing subject matter that is not described in the specification in such a way as to reasonably convey to one skilled in the art that the inventor, at the time the application was filed, had possession of the claimed invention. This rejection, insofar as it pertains to the presently pending claims, is respectfully traversed.

As set forth on page 3 of the Office Action, the rejection under 35 U.S.C. § 112, first paragraph is based on the Examiner's assessment that:

> The specification and the claims fail to teach *adequately* that how could the first convergent means being fixed to the second substrate is capable of **both** collimating and reimaging the light beams. The applicant is respectfully reminded that "collimating", which means making parallel, is completely different from "reimaging", which means making converging or focusing, function. Claims 2-13 and 15-16 inherit the rejection from their respective based claim.

Initially, Applicant notes that original claim 1 has been cancelled in favor of new apparatus claim 17, which specifies that the second substrate has a first light converging means for "substantially collimating" light from points of the first object pattern, and further recites "reimaging means" for reimaging the "substantially collimated light". Applicant respectfully notes that this arrangement is entirely consistent with that discussed in the disclosure with reference to Fig. 1. Furthermore, Applicant notes that an element which

"substantially collimates" light may result in light which is slightly converging, and, thus, it is not inconsistent to refer to substantially collimated light being used to reimage a pattern.

At least in view of the claim amendments and remarks set forth above, Applicant respectfully requests reconsideration and withdrawal of the Examiner's rejection under 35 U.S.C. § 112, first paragraph.

Rejection Under 35 U.S.C. § 112, Second Paragraph

Claims 1-13 and 14-16 stand rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite. This rejection, insofar as it pertains to the presently pending claims, is respectfully traversed.

Initially, in reply to the Examiner's general assessment that the claims fail to conform with current U.S. practice as being narrative, etc., Applicant has cancelled original claims 1 and 14 in favor of new independent claims 17 and 19. These new independent claims have been presented in proper U.S. format and are believed to render moot many of the grounds of indefiniteness cited by the Examiner on pages 3-4 of the Office Action. Regarding the Examiner's statement that the phrase "encoding of relative position" is confusing, Applicant has written claims 17 and 19 in a manner that clearly recites that the apparatus/method set forth therein defines relative position of multiple components, specifically stating that features thereof define the position of a first substrate relative to a second substrate.

The alternative phrase "and/or" has been removed from the claims. Furthermore, new claims have been drafted to avoid the antecedent basis issues identified by the Examiner on page 4 of the Office Action. With regard to the phrases "object axis" and "in use," Applicant submits that these phrases are clear, particularly when viewed in light of the

specification. If this rejection is maintained, Applicant respectfully requests that the Examiner provide some indication of why such phrases are somehow confusing when considered in light of the specification. Regarding the phrase "is not repeated within" in claim 15, this phrase has been deleted. Finally, with regard to the phrase "lens elements adjacent to the first cylindrical lens element," Applicant respectfully submits that the amendments to claim 2 presented above have clarified the meaning of this phrase.

In view of the above, Applicant respectfully requests reconsideration and withdrawal of the rejection under 35 U.S.C. § 112, second paragraph.

Prior Art Rejection

Claims 1-16 stand rejected under 35 U.S.C. § 103 as being unpatentable over *Street* (WO 97/22033) in view of *Young* (U.S. Patent 5,689,340). This rejection, insofar as it pertains to the presently pending claims, is respectfully traversed.

Initially, since independent claims 1 and 14 have been cancelled in favor of new independent claims 17 and 19, respectively, Applicant addresses the grounds of rejection insofar as it may be deemed to pertain to new independent claims 17 and 19. Independent claim 17 is directed to an apparatus which defines relative position of multiple components thereof. The apparatus of claim 17 comprises: a first substrate having a first plurality of light transmitting and light blocking regions, which aggregately form a first object pattern of juxtaposed stripes in an object plane; a second substrate having first light converging means fixed thereto for substantially collimating in a first orthogonal plane, being orthogonal to the object plane, light from points of the first object pattern; reimaging means for reimaging the substantially collimated light in a first image plane and forming a first image pattern corresponding to the first object pattern; and

first image detection means positioned at the first image pattern for capturing a first image portion comprising a portion of the first image pattern. The first object pattern is non-repeating and the first image portion, corresponding to the juxtaposed stripes, has a sequence of alternating and juxtaposed light and dark regions of varying widths, the sequence defining the location of the first image portion within the first image pattern corresponding to the first object pattern, thereby defining the position along a first object axis of the first substrate relative to the second substrate.

New independent claim 19 is directed to a method for defining the relative position of two substrates. The method of claim 19 comprises: providing a source of light; providing a first substrate at a position relative to a second substrate, the first substrate being located intermediate the second substrate and the source of light, the second substrate including first light converging means; providing a pattern comprising a plurality of light transmitting and light blocking regions as juxtaposed stripes to provide a first object pattern in an object plane, the object plane being comprised within the first substrate; substantially collimating in a first orthogonal plane, being orthogonal to the object plane, light from points of the first object pattern; reimaging the substantially collimated light in a first image plane and forming a first image pattern corresponding to the first object pattern; and capturing , using first image detection means, a first image portion comprising a portion of the first image pattern. The pattern includes stripes and gaps between the stripes of varying widths, thereby creating a non-repeating pattern, and the capturing step includes defining the location of the first image portion within the first image pattern by reference to a captured portion of the non-repeating pattern and thereby the position along a first object axis of the first substrate relative to the second substrate.

Regarding the primary reference, *Street*, Applicant acknowledges that *Street* discloses the concept of a pattern mask, which acts as a barrier screen. Applicant respectfully submits, however, that this disclosure in no way provides for one or more patterns with the characteristics as set forth in the above-identified claims. The barrier screen of *Street* repeats itself identically on a pitch approximately equal to that of the corresponding lens element of a lenticular screen. The sole purpose of the mask acting in conjunction with the screen is to provide viewing zones for the observer of an autostereoscopic display incorporating these elements. Therefore, the arrangement of *Street* relied on by the Examiner does not define the positioning of elements as set forth in new independent claims 17 and 19.

Regarding the secondary reference, *Young*, this reference is concerned with the lateral position and alignment (angle) of the lenses of a modified lenticular screen, typically for printing lenticular prints. The imaging properties of the cylindrical lens elements are employed to provide a light pattern when illuminated with collimated light. This arrangement allows precise determination of lateral location of the lens elements of a lenticular sheet relative to a datum determined by the position of a camera which views the light pattern under specific (collimated) lighting conditions. The arrangement is not concerned with determining the relative position between two substrates, the first of which comprises a non-repeating pattern and the second of which comprises a convergent element, which is employed to substantially collimate light from at least a part of the pattern of the first substrate. It is respectfully submitted that *Young*, which is principally concerned with determining the lateral position of lenticular material, fails to teach or suggest defining

relative position of first and second substrates in the manner required by independent claims 17 and 19.

To establish *prima facie* obviousness, all claim limitations must be taught or suggested by the prior art and the asserted modification or combination of prior art must be supported by some teaching, suggestion, or motivation in the applied reference or in knowledge generally available to one skilled in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). Thus, "[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). The prior art must suggest the desirability of the modification in order to establish a *prima facie* case of obviousness. *In re Brouwer*, 77 F.3d 422, 425, 37 USPQ2d 1663, 1666 (Fed. Cir. 1995). It can also be said that the prior art must collectively suggest or point to the claimed invention to support a finding of obviousness. *In re Hedges*, 783 F.2d 1038, 1041, 228 USPQ 685, 687 (Fed. Cir. 1986); *In re Ehrreich*, 590 F.2d 902, 908-09, 200 USPQ 504, 510 (CCPA 1979).

At least for the above reasons, Applicant submits that the asserted combination of *Street* and *Young* (assuming these references may be combined, which Applicant does not admit) fails to establish *prima facie* obviousness of claim 17 or 19, or any claim depending therefrom.

In view of the above, Applicant respectfully requests reconsideration and withdrawal of the Examiner's rejection under 35 U.S.C. § 103.

CONCLUSION

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact D. Richard Anderson (Reg. No. 40,439) at the telephone number below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

Applicant respectfully petitions for a three (3) month extension of time pursuant to 37 C.F.R. §§ 1.17 and 1.136(a). A check in the amount of $465.00 in payment of the extension of time fee is attached.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

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DRA/jdm
0787-0117P

Attachments: Version With Markings to Show Changes Made
Substitute Specification
Marked-up Version of Substitute Specification

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Please see the attached marked-up version of the Specification.

IN THE CLAIMS:

Claims 1, 6, 14, and 16 have been cancelled without prejudice or disclaimer of the subject matter contained therein.

The claims have been amended as follows:

2. (Amended) Apparatus as claimed in Claim 17 in which the second substrate is a lenticular screen; the first convergent means comprises a first cylindrical lens element of said screen; said lenticular screen includes lens elements adjacent to said first cylindrical lens element; and the first orthogonal plane is orthogonal to the longitudinal axis of said first cylindrical lens element.

3. Apparatus as claimed in Claim 2 including elongate aperture means fixed with respect to the lenticular screen and arranged to block light which passes through lens elements adjacent to the first cylindrical lens element.

4. (Amended) Apparatus as claimed in Claim 3 in which the aperture means comprises an opening in an opaque coating on a portion of the front surface of the lenticular screen.

5. (Amended) Apparatus as claimed in Claim 17 in which the widths of the light and dark regions are determined by locating, with the first image detection means, at least three boundaries between the images of said light and dark regions within said first image portion thereby providing the data to unambiguously define the identity of one of the corresponding juxtaposed stripes and the location thereof along the first object axis relative to the first convergent means.

7. (Amended) Apparatus as claimed in Claim [6] 18 in which the position along the first object axis [the first image portion's location along the first image axis] provides a first ordinate; the position along the second object axis [the second image portion's location along the second image axis] provides a second ordinate; and said first and second ordinates are combined to provide the position of the first substrate relative to the second substrate.

8. Apparatus as claimed in Claim 7 in which the first and second patterns are tapered so that the width of each stripe reduces from one end to the other.

9. (Amended) Apparatus as claimed in Claim 7 in which the first object axis and the second object axis are inclined with respect to [eachother] each other and, in use, the position of the first substrate relative to the second substrate is provided in two orthogonal directions.

10. (Amended) Apparatus as claimed in Claim 7 in which the second substrate is a lenticular screen having a tapered structure in which the first convergent means comprises a first cylindrical lens element of said screen having a first principal axis and the second convergent means comprises a second cylindrical lens element of said screen spaced from said first lens element and having a second principal axis and in which said first and second principal axes are inclined with respect to [eachother] each other.

11. Apparatus as claimed in Claim 9 comprising means for controlling the relative positions of the substrates in the two orthogonal directions.

12. (Twice Amended) Apparatus as claimed in claim [1] 17 in which at least one of the image detection means comprises a linear CCD array.

13. (Amended) Apparatus as claimed in Claim 17 in which the first substrate comprises a barrier screen and the first and second substrate provide in combination at least one viewing zone for an autostereoscopic display system.

15. (Amended) The method of Claim 19 [14] which includes [arranging the first plurality of juxtaposed transmitting and blocking stripes to comprise a selection of respective gaps and widths in such a manner that a particular sequence of said gaps and widths is not repeated within said first object pattern;] locating [with the first image detection means] at least three boundaries between the corresponding light and

dark regions in the first image portion and thereby establishing the identity of a corresponding stripe in the first object pattern and the location thereof along the first object axis relative to the first convergent means.

New claims 17-20 have been added.

MARKED-UP VERSION OF SUBSTITUTE SPECIFICATION

METHOD AND APPARATUS FOR CONTROL OF VIEWING ZONES

This application is the national phase under 35 U.S.C. § 371 of the PCT International Application No. PCT/GB00/00006 which has an International filing date of January 6, 2000, which designated the United States of America and was published in English.

This invention is concerned with the field of three-dimensional imaging and particularly with the control of the position in space of the viewing zones required for an observer to view a three-dimensional image without the use of special viewing aids.

BACKGROUND

International Patent Application WO94/20875 (Street) describes apparatus in which two two-dimensional perspective images, provided by conventional liquid crystal display (LCD) panels, are combined with the aid of a semi-transparent mirror, so that each eye of the observer sees a different perspective but in the same location. This causes the brain to fuse these perspectives into one three-dimensional image. The principal purpose of the aforementioned invention is to avoid the need for the observer to wear special spectacles. International Patent Application WO97/22033 (Street) apparatus is described which provides, simultaneously, both right and left eye images from a single LCD. Three-dimensional images provided in this way are generally referred to as autostereoscopic.

In certain embodiments described in both of the aforementioned publications, WO94/20875 and WO97/22033, the position of the viewing zone for each of the respective eyes of the observer is controlled by the precise relative positioning of two complementary optical components. The first of these comprises a regular array of juxtaposed cylindrical lens elements, or lenticles, fixed to and supported by a transparent substrate and is commonly referred to as a lenticular screen. The second and complementary component, which is positioned behind and close to the lenticular screen, comprises an array of light blocking regions on a transparent substrate. These blocking regions may take the form of long strips, as in WO94/20875, or they may be arranged in a chequered fashion, as in WO97/22033. European Patent Application EP 0 788 008 (Naosato et al.) describes apparatus similar to that of WO97/22033, although it is silent in respect of how to achieve observer tracking. This is a key objective of the current

invention and is referred to, in principle, in both WO94/20875 and WO97/22033. Therein, by providing both the lenticular screen and the blocking pattern, referred to hereinafter as a barrier screen, with a vertically tapered structure and controlling the relative position of one with respect to the other, the lateral position of a viewing zone and its distance from the apparatus may be controlled. Such control is required at right angles to the long axes of the lenticles for horizontal displacement of the zone and along the axis of the central lenticle (vertically) for a relative change in local scale between the lenticular and barrier screens. This change of local scale gives rise to a change in the convergence of light leaving the apparatus from adjacent lenticles and, thus, adjusts the point of convergence and the distance of the viewing zone from the apparatus.

The required accuracy in the positioning of the lenticular screen, relative to its corresponding barrier screen, is high, as the optical magnification of the pattern of the barrier screen, which gives rise to the viewing zones, may be as high as 300 : 1. Typically, relative and rapid positioning to an accuracy of a few microns is desirable in the lateral direction, whereas the orthogonal positioning requirement, will be less demanding. If a conventional control loop was applied to each component, each would be permitted one degree of freedom, all others being constrained to the required precision. In addition, the structural stability of the system, as a whole, would have to be high, so as to avoid changes of scale due to temperature changes or mechanical creep in the position of components.

A proposed method for controlling the position of a lenticular screen relative to an LCD to provide an autostereoscopic image is described in UK Patent Application GB 2317771 A (Woodgate et al.). The features of the embodiments described in this prior art include, inter alia, firstly the need to analyse visible or infrared images of the observer and to use these signals to control, directly, the alignment of the lenticular screen relative to the image providing LCD, secondly one or more detector assemblies which are positioned with great accuracy relative to the pixel array of the LCD. Preferably the photodetectors are integrated within the LCD's construction. The aforementioned PCT Applications seek, in their preferred embodiments, to use standard LCD devices which have not been specifically adapted for stereoscopic use. Furthermore, these LCD's are typically positioned in front of a structured light source, thus being capable of conventional use, and do not form part of the observer tracking system.

Further general background to the state-of-the-art which has relevance to the current invention may be found in EP 0 743 552 (Fogel et al.). Here the objective is to register a segmented print, comprising many different perspectives of a three-

dimensional scene, very precisely behind a lenticular screen prior to lamination for viewing by an observer. This is achieved by having a regular array of reference marks on the image bearing print, outside the viewable area, and observing the Moiré pattern between these small patterns and the regular array of cylindrical lens elements that make up the lenticular material. Two such patterns positioned at the top and bottom of the image to be registered can allow both lateral registration and the removal of any rotational error. There is no provision for adjusting the relative scale of the pitch between the segments of the print and that between the elements of the ~~lentiecualr~~lenticular screen. Furthermore, the process does not provide an absolute lateral position, but a multiplicity of solutions, as registration is only required with respect to the nearest lens element of the screen.

SUMMARY OF THE INVENTION

It is an object of the current invention to provide a system for the control of the lateral position of a lenticular screen relative to a corresponding barrier screen, to provide a stable and accurately located viewing zone, without the need for the structural ~~stablity~~stability which would be demanded using independent control means for each of these components.

It is a further object of the invention to provide a convenient means for controlling the distance of the viewing zone from the apparatus.

It is another object of the invention to provide automatic compensation for any changes in relative scale or positioning, due to mechanical creep or thermal changes.

Thus, according to the invention, apparatus for the encoding and control of relative position of components within an autostereoscopic display system comprises a first substrate having a first plurality of light blocking and light transmitting regions comprising in aggregate a first object pattern in an object plane; a second substrate positioned relative to and/or spaced from said first substrate; first convergent means fixed relative to said second substrate for substantially collimating in a first orthogonal plane, said orthogonal plane being orthogonal to said object plane, light from points of said first object pattern to provide or subsequently form, in use, a first image pattern corresponding to said first object pattern at a first image plane; and first image detection means positioned at said first image plane for capturing a first image portion comprising a portion of said first image pattern, characterised in that said first image portion contains sufficient image data to unambiguously define its location within said

first image pattern along a first image axis corresponding to a first object axis at said first object pattern whereby, in use, the relative position along said first object axis of the first substrate relative to the second substrate is determined.

Preferably the second substrate is a lenticular screen; the first convergent means comprises a first cylindrical lens element of said screen; and the first orthogonal plane is orthogonal to the longitudinal axis of said first cylindrical lens element.

Advantageously elongate aperture means is fixed with respect to the lenticular screen and arranged to block light which passes through lens elements adjacent to the first cylindrical lens element. The aperture means may comprise an opaque coating on a portion of the front surface of the lenticular screen

The first object pattern on the first substrate may comprise alternate, juxtaposed light blocking and transmitting stripes having respectively a selection of widths and gaps and arranged so that, in use, the locating, with the first image detection means, of at least three boundaries between the images of light transmitting and light blocking stripes within said first image portion provides the data to unambiguously define the identity of one of said stripes and the location thereof along the first object axis relative to the first convergent means. Preferably a particular sequence of widths and gaps is not repeated within the object pattern.

Advantageously the first substrate has a second plurality of light blocking and light transmitting regions comprising in aggregate a second object pattern in the object plane; second convergent means fixed relative to the second substrate for substantially collimating in a second orthogonal plane, said second orthogonal plane being orthogonal to said object plane, light from points of said second object pattern to provide or subsequently form a second image pattern corresponding to said second object pattern at a second image plane; and second image detection means positioned at said second image plane for capturing a second image portion comprising a portion of said second image pattern, in which said second image portion contains sufficient image data to unambiguously define its location within said second image pattern along a second image axis corresponding to a second object axis at said second object pattern whereby, in use, the relative position along said second object axis of the first substrate relative to the second substrate is determined.

In certain embodiments the first image portion's location along the first image axis provides a first ordinate; the second image portion's location along the second image axis provides a second ordinate; and said first and second ordinates are combined to provide the position of the first substrate relative to the second substrate.

Preferably the second substrate is a lenticular screen having a tapered structure in which the first convergent means comprises a first cylindrical lens element of said screen and the second convergent means comprises a second cylindrical lens element of said screen spaced from said first lens element. The first and second patterns may be tapered, so that the width of each stripe reduces from one end to the other, and the first object axis and the second object axis may be inclined with respect to each_other so that the position of the first substrate relative to the second substrate can be provided in two orthogonal directions.

Advantageously, means for controlling the relative positions of the substrates in the two orthogonal directions is provided. In preferred embodiments the image detection means includes one or more linear CCD arrays. A sequence of three transitions or boundaries between transmitting and blocking regions can unambiguously define the location of these boundaries within the pattern of which they form part.

DESCRIPTION OF PREFERRED EMBODIMENTS

The invention will now be described with reference to Figures 1 to ~~and 3~~ 2 ~~in~~ which:-

Figure 1 shows a section through position encoding apparatus constructed in accordance with the invention, together with a diagrammatic illustration of encoded position data, derived therefrom~~,~~

Figure 2 shows how two degrees of freedom for relative positioning may be provided in accordance with the invention and

Figure 3 is an isometric view of the apparatus of Figures 1 and 2.

A typical arrangement for encoding the position of a lenticular screen relative to a barrier screen is shown in Figure 1. A lenticular screen 1 is positioned in front of a barrier screen 2. A plurality of light transmitting regions and light blocking regions, shown respectively as light and bold line segments on the front surface 3 of barrier screen 2, are arranged side-by-side in an alternating fashion, thereby being juxtaposed to form in aggregate a defined pattern. One of the lenticular screen's lenses 4 is isolated from its neighbours by a narrow aperture in plate 5. This is typically considerably longer than its width, given the cylindrical nature of the lenticular screen's lens elements (lenticles). Lenticle 4 is a convergent element which collimates light from points on surface 3 to pass through the aperture in plate 5. Surface 3 may therefor be regarded as an object plane at which is situated an object pattern. The collimating action of the lenticle occurs in a plane

substantially orthogonal to both the object pattern and the longitudinal axis of the cylindrical lenticle 4. In this embodiment of the invention, lenticle 4 has a focal length of about 3 mms and collimates the light from the pattern and, so, a lens 6, with a focal length of approximately 20 mms reimages this light to form, in one dimension, a magnified image of part of the pattern at surface 3 on an image capture device in the form of a linear CCD array 7. This is the image detection means required to analyse features within the image. This arrangement is shown isometrically with lens 6 partially cut away and element 4 renumbered as 25 to aid clarity in Figure 3. As will be clear to one versed in the art, it is possible to arrange for some additional convergence of light in the orthogonal plane, by a small adjustment of the distance from object plane 3 to lenticle 4, to form the image of the pattern, following passage through the lenticle, in which case lens 6 would not be required, as the lenticle would reimage the light whilst remaining substantially a collimating element.

Many different configurations in terms of scale and magnification of the object pattern are possible. In the example given the pattern comprises light providing stripes and dark spaces having gap sizes and widths which substantially equate to an integral multiple of one quarter of the pitch between the lens elements of the lenticular screen. A typical pitch between lenses in an autostereoscopic display system would be 0.6 mm, though larger and smaller lens pitches may conveniently be employed. If the whole of the pattern at surface 3 were to be imaged simultaneously onto the CCD's surface and lens element 4 behaved as a perfect imaging element, then the width of the pattern to be imaged would be approximately 6 mms and the field of view of this element would have to be greater than 90° if the whole of the image were to be viewed simultaneously. If the image formed had no distortion, then the CCD's signal and the image would correspond to the schematic representation 8. In practice, this is found to be impractical and is not necessary, as a portion of the image of the pattern is sufficient. Light transmitting gaps form image components such as 9 and 10. A blocking region creates a dark space 11. The relative widths of the blocking regions, the sizes of the gaps between them provided by the transmitting regions and the order in which these light and dark regions are arranged unambiguously defines which portion of the image of the pattern is captured on the CCD. In fact, only three transitions are required for the particular pattern illustrated to extract the data needed to unambiguously define their exact position within the pattern to the accuracy that the CCD can provide. The pattern illustrated comprises three intrinsic relative dimensions for both the width of blocking regions and the gaps between them. No sequence comprising three transitions or boundaries between a

transmitting gap or blocking region, thereby comprising one dark region having a width and one light gap of a particular relative size, is repeated within the pattern as a whole. Representing a light gap as being one (1L), two (2L) or three (3L) units in magnitude, and likewise the dark regions as having one (1D), two (2D) or three (3D) units of width, the particular pattern, used in the example given, comprises the following groupings of three transitions, each comprising, in full, a dark and a light region:-

2L3D, 3D3L, 3L2D, 2D1L, 1L3D, 3D2L, 2L1D, 1D1L, 1L2D,

2D2L, 2L2D, 2D3L, 3L1D, 1D3L, 3L3D, 3D1L, 1L1D, 1D2L

As the barrier screen is moved laterally 12 with respect to the lenticular lens 4, the pattern shifts on CCD 7, and different groupings of transitions may be used to determine the relative lateral position of the barrier screen 2 with respect to the lenticular screen 1. More precisely, the relative position of the object pattern on surface 3 of the barrier screen is determined relative to the axis of the lenticular element 4. In practice, this is conveniently done by locating the midpoint of the light region which is closest to a predetermined location on CCD 7, this point being substantially at the intersection of the optical axis of the lens element and the surface of CCD 7. To allow for transitions from one midpoint to the next, the practical field of view of lens element (4) must be such that any two neighbouring light regions can be brought into view simultaneously. In the illustrated example, this requires a field of view of approximately 23°, which is easily accommodated. Typically a conventional diffuse light source 13 is positioned behind the barrier screen 2.

Figure 2 illustrates how the use of two patterns on the barrier screen may be used to determine the position of the latter relative to the lenticular screen in front of it in two orthogonal directions. For the sake of diagrammatic convenience, the two patterns 20 and 21 are shown close together and at considerable magnification. In practice, a considerable gap would be typical, with one pattern on the left hand side of the barrier screen and the other on the right hand side. This typical arrangement is illustrated in the isometric view provided by Figure 3. Returning to Figure 2, t~~T~~wo apertures 22 and 23 are shown schematically. For the sake of clarity the lenticular screen 1, which is situated in between the apertures and the barrier screen, is not included here, but is shown in Figure 3. Each of the apertures is positioned to block light passing through lenticles adjacent to a different one of two spaced lenticles 25 and 26 (Figure 3) on the lenticular screen. This provides respectively a first 25 and a second 26 convergent cylindrical lens element for forming ~~seperate~~separate images of the spaced patterns 20 and 21 at different

image planes 27 and 28 associated with corresponding CCD detectors 7 and 29, each of which is shown using a broken line format in Figure 3 to aid clarity. Also illustrated is a deliberate taper between the two patterns 20 and 21. As the barrier screen is moved up and down 24 relative to the apertures, there will be a component of movement orthogonal to the long axis of the stripes within each pattern and different portions thereof will become central to the field of view of the corresponding CCD (as provided in Figure 1 and not shown in Figure 2). Each of these detection arrangements has a different orthogonal plane defining a direction or axis (A1, A2) of measurement at the object pattern and at the corresponding image plane. When the lenticular screen and the barrier screen have an intrinsically tapered structure, as employed in the embodiments of the aforementioned WO94/20875 and WO97/22033, it is the up and down relative motion 24 which controls the convergence of the light transmitted through the lenticular structure and thus the distance or longitudinal positioning of the resulting viewing zone or zones. The directions of the measurement axes are inclined with respect to each other at the plane where the object patterns are located. This enables two different ordinates to be obtained and these provide, in a simple manner, a measure of both the lateral relative motion 12 between the lenticular and the barrier screen and their relative motion in the orthogonal (vertical) direction 24. By employing oppositely tapered patterns, as illustrated, the change in relative position derived from each CCD is opposed when the relative motion is vertical and has the same sign when the motion is lateral. Thus, by averaging the resulting relative motions, an accurate lateral position is derived and, by establishing the difference in the two relative positions detected, a term proportional to the relative vertical movement is obtained. The proportionality constant depends on the inclination of one pattern relative to that of the other. It will be clear that a small angle of inclination between the two ordinate axes, as illustrated, can provide a measurement in the two required orthogonal directions, but that the result will have greater accuracy for horizontal motion than for the vertical. Conveniently, this is completely compatible with the requirements of an autostereoscopic display system, where lateral positioning of the viewing zones must be accurate and fast, but where there is considerable tolerance in the longitudinal positioning thereof.

The height of the apertures 22 and 23 may be small, as illustrated in Figure 2, if horizontal relative motion between lenticular and barrier screen is achieved by moving the lenticular screen relative to the detection system. However, in the case of the preferred embodiment of WO97/22033, it is the lenticular screen which is moved in a vertical direction relative to the overall assembly and, in this case, the

height (or length) of apertures 22 and 23 must accommodate the full extent of this motion. In such embodiments, it is convenient to form the apertures on the surface of the lenticular screen by providing an opaque coating or layer on its surface. This has a clear region on that part of the surface which comprises the image forming lenticle.

Simple actuators such as stepper motors, DC motors or voice coils (not shown) may be used to position the two substrates (lenticular and barrier screen) relative to one another. Since position feedback for both directions of relative motion is obtained directly from the relative positions of the two screens or substrates, substantial accuracy is maintained without high cost. Even dimensional changes due, for example, to manufacturing tolerances or temperature effects are accommodated. This is particularly true of the tapered structure, in which a relative change of scale of the barrier screen or lenticular screen would automatically be compensated for by the necessary correction in the relative positions of these two components.

It will be clear to those versed in the art that the principles of this invention are not limited to the control of the relative position of a lenticular screen with respect to a corresponding barrier screen. Other components requiring optical position monitoring and/or control might benefit from similar arrangements. Although the object patterns illustrated comprise transparent regions, which would typically be back lit with a diffuse light source, it would be quite practical to replace such regions with appropriately shaped light emitting elements such as, for example, might be provided using light emitting polymers. In general the regions which are light blocking prevent light from leaving points from their location at the object plane. These are, therefore, light inhibiting. Conversely, the regions which are light transmitting could be replaced by regions which are light emitting, whether this light be generated at the object plane or elsewhere and re-emitted at its surface. This would include specularly reflected light. These are therefore in general light providing regions. Any reference herein to light blocking regions or stripes is therefore deemed to include light inhibiting ones and any reference herein to light transmitting regions is deemed to include light providing ones.